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U.S. DEPARTMENT OF COMMERCE  
PATENT AND TRADEMARK OFFICEUTILITY PATENT APPLICATION  
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UNDER 37 C.F.R. 1.53(b)

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Address to:

Assistant Commissioner for Patents  
Washington D.C. 20231  
Box Patent Application

Transmitted herewith for filing is a patent application.

Inventor(s): Harald NEUMANN

For: **ARRANGEMENT FOR WIRING AN ELECTROCHEMICAL SENSOR**

1. Enclosed are:

- ☒ 2 sheet(s) of drawing(s).  
☒ A declaration/power of attorney. (unsigned)  
☒ An Information Disclosure Statement along with an accompanying  
PTO-1449 form.  
☐ Other: \_\_\_\_\_

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Respectfully submitted,

*Richard L. Mayer*

Dated: 8/6/99

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## ARRANGEMENT FOR WIRING AN ELECTROCHEMICAL SENSOR

Background Information

Electrochemical solid electrolyte sensors, in particular for determining the oxygen content in exhaust gases of internal combustion engines, operate according to the so-called Nernst principle, according to which an electromotive force (EMF) is picked off, as the probe voltage, between a reference electrode having an excess of oxygen and a measurement electrode to which the measured gas is applied. The EMF occurs if an oxygen concentration  $\lambda < 1$  is present in the measured gas, stoichiometric conditions being present in the measured gas when  $\lambda = 1$ . The probe voltage is conveyed to a control device as a measurement signal. Electrochemical solid electrolyte sensors require a temperature of at least 300°C in order to operate. An electrical resistance heater, operated with a heating voltage that corresponds (when the sensor is used in a motor vehicle) to the vehicle's battery voltage, is integrated into the solid electrolyte sensor for that purpose. The reference electrode of the solid electrolyte sensor is connected as the positive electrode. The measurement electrode is connected to ground (negative pole). When solid electrolyte sensors are operated, it is found that coupling of the heat voltage into the probe voltage occurs. This falsifies the measurement signal. It has already been proposed to separate the sensing element and the heater from one another, or to provide between the heater and the adjacent electrode a shielding electrode to dissipate the coupled-in voltage (see German Patent Application No. 31 20 159).

Summary Of The Invention

The arrangement according to the present invention has the advantage that coupling of the heater voltage can effectively be blocked with simple means.

Coupling is most effectively prevented if the electrode adjacent to the resistance heater lies in a layer plane of the solid electrolyte element, and has at least approximately the surface extent of the further electrode.

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### Brief Description Of The Drawings

Figure 1 shows a cross section through a solid electrolyte sensor having a wiring layout as defined in the existing art.

5 Figure 2 shows a cross section through a first exemplary embodiment of a solid electrolyte sensor in accordance with the wiring layout according to the present invention.

10 Figure 3 shows a cross section through a second exemplary embodiment of an electrochemical solid electrolyte sensor.

### Detailed Description

15 Figure 1 shows an electrochemical oxygen sensor with a schematic depiction of an electrical wiring layout. The sensor has a ceramic element 11 made of a ceramic that conducts oxygen ions (for example stabilized  $\text{ZrO}_2$ ), a measurement electrode 12, and a reference electrode 13. Measurement electrode 12 is exposed to a measured gas. Reference electrode 13 is arranged in a reference duct 15 that communicates with a reference gas, e.g. air. An electrical resistance heating element 17 that is embedded in an electrical insulator 18 is integrated into ceramic element 11.

20 The electrical wiring layout of electrodes 12, 13, and resistance heater 17 is depicted schematically, resistance heater 17 being operated with a heating voltage  $U_H$  of, for example, 12 V. The negative terminal is connected to ground. Measurement electrode 12, constituting the negative electrode, is also connected to ground. Reference  
25 electrode 13 is operated as the positive electrode.

30 Figure 2 shows the same solid electrolyte sensor as in Figure 1, but with the electrical wiring layout according to the present invention, according to which reference electrode 13, constituting the positive electrode, is connected to ground. Measurement electrode 12 is wired as the negative electrode. According to the present invention, the electrode located closest to resistance heater 17 - which in the present case is reference

electrode 13 - is connected to ground. A negative probe voltage  $U_s$  is thereby created. The result is that a negative operating voltage  $U_B$ , which powers a circuit arrangement for analyzing the negative probe voltage  $U_s$ , is made available via a circuit that is known per se. The necessary circuit for generating a negative operating voltage  $U_B$  is known per se and available to one skilled in the art.

A further exemplary embodiment of an oxygen sensor is evident from Figure 3. What is arranged here is a reference electrode 20 that extends over the width of reference duct 15 and possesses, approximately in the layer plane, the surface extent of measurement electrode 12. The larger-area reference electrode 20 thus additionally acts as a shield against any coupling of heater voltage  $U_H$  into measurement electrode 12. The further elements of the exemplary embodiment in Figure 3 correspond to the exemplary embodiment in Figure 2.

The present invention is not limited to the exemplary embodiments of planar oxygen sensors described above. It is just as conceivable also to utilize the proposed electrical wiring layout in solid electrolyte sensors of so-called finger shape, i.e. having a solid electrolyte element that is constituted by a solid electrolyte tube that is closed on one side.

The wiring layout according to the present invention is moreover also usable in electrochemical pump cells in which oxygen is pumped by application of a pump voltage, and the limiting current which flows in that context is utilized as the measurement signal. The negative operating voltage  $U_B$  is used in this context as the pump voltage.

What Is Claimed Is:

1. An electrochemical sensor comprising:  
a solid electrolyte element including at least one first electrode, at least one second electrode and at least one heating element, the at least one second electrode being situated closer than the at least one first electrode to the at least one heating element, the at least one second electrode being coupled to ground, the at least one first electrode coacting with the at least one second electrode and being negatively polarized.
2. The sensor according to claim 1, further comprising an arrangement for providing a negative operating voltage.
3. The sensor according to claim 2, further comprising a measurement circuit, the negative operating voltage powering the measurement circuit.
4. The sensor according to claim 2, further comprising a circuit arrangement for analyzing a negative probe voltage, the negative operating voltage powering the circuit arrangement.
5. The sensor according to claim 1, wherein the at least one second electrode lies in a layer plane of the solid electrolyte element, the at least one second electrode having approximately the same surface size as the at least one first electrode.
6. The sensor according to claim 1, wherein the at least one second electrode is a reference electrode communicating with a reference atmosphere, and the at least one first electrode is a measurement electrode.

Abstract Of The Disclosure

An electrochemical sensor, in particular for determining the oxygen content in exhaust gases of internal combustion engines, has a solid electrolyte element having at least one first electrode, at least one second electrode, and at least one heating element.

- 5 The second electrode located closest to the heating element is connected to ground, and the first electrode coating with the second electrode is negatively polarized, a negative operating voltage being provided.

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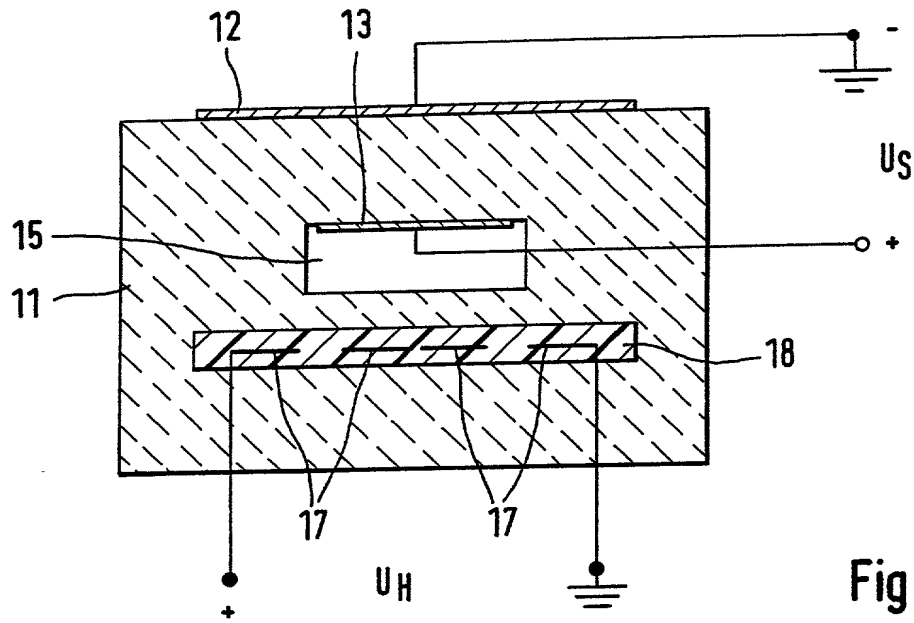


Fig.1

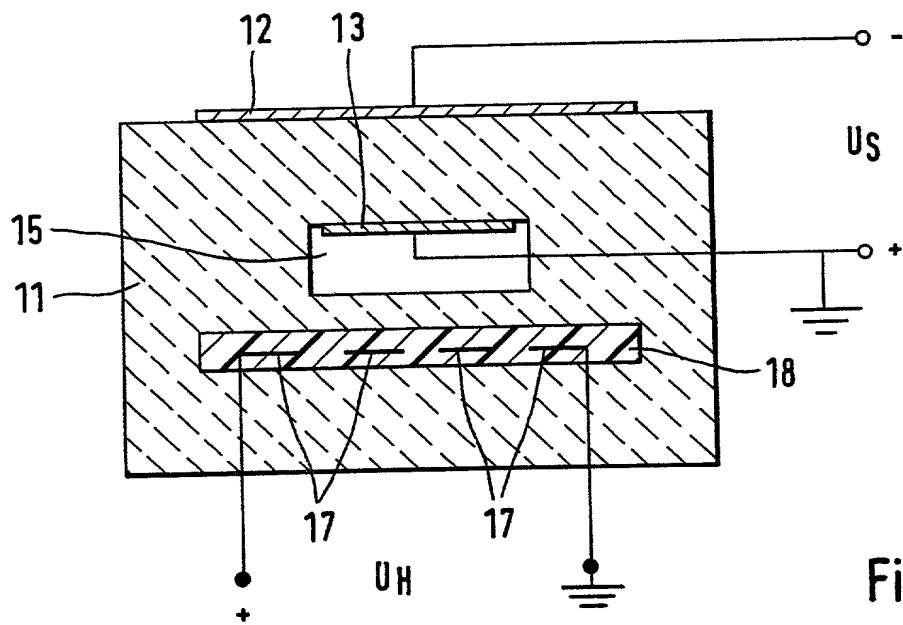


Fig.2



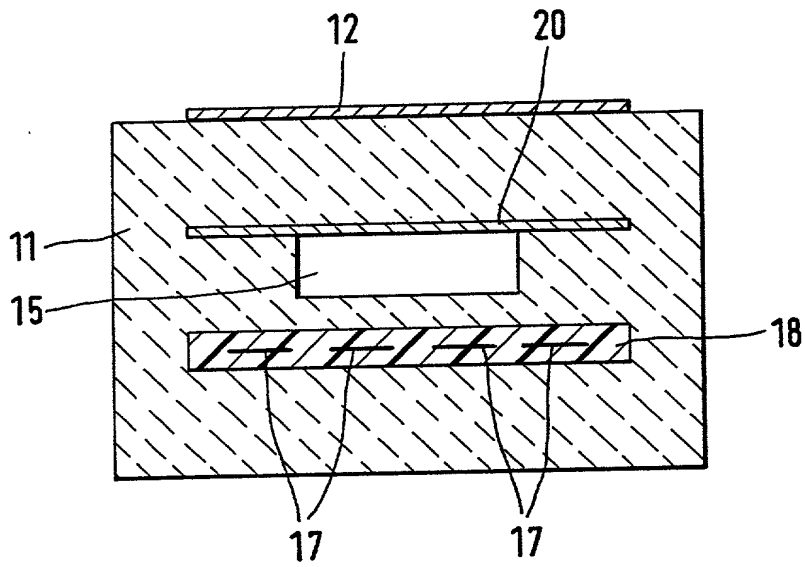


Fig.3

**COMBINED DECLARATION AND  
POWER OF ATTORNEY FOR PATENT APPLICATION**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below adjacent to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled "**ARRANGEMENT FOR WIRING AN ELECTROCHEMICAL SENSOR**," the specification of which:

- ☒ is attached hereto;
- ☐ was filed as United States Application Serial No. \_\_\_\_\_ on \_\_\_\_\_, 19\_\_ and was amended \_\_\_\_\_ (if applicable).
- ☐ was filed as PCT International Application Number \_\_\_\_\_, on the \_\_\_\_ day of \_\_\_\_\_ 19\_\_.
- ☐ an English translation of which is filed herewith.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international applications(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

EC1799555/2US

**PRIOR FOREIGN/PCT APPLICATION(S)  
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119**

Country : Federal Republic of Germany

Application No. : 1 98 35 766.4-52

Date of Filing : August 7, 1998

Priority Claimed

Under 35 U.S.C. § 119 : ☒ Yes ☐ No

I hereby claim the benefit under Title 35, United States Code § 120 of any United States Application or PCT International Application designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations § 1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

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STATUS (Check One)

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I hereby appoint the following attorney(s) and/or agents to prosecute the above-identified application and transact all business in the Patent and Trademark Office connected therewith.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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